

Low-Temperature Handling of Sterilized Foods. VI.

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Color and Flavor of Canned Soups, Tomato Juice, and Evaporated Milk^{a,b}

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SUMMARY

Color and flavor were evaluated for several liqueform products processed by HTST sterilization, conventional canning, and freezing, and stored at 25, 35, 50, and 85°F for 3, 6, 12, 18, and 24 months. Color was affected most by storage time, the most rapid changes occurring during the first 6 months of storage. Hue was best maintained by freezing; brightness by HTST sterilization. Conventional canning produced the greatest changes in color due to processing and storage. Flavor was affected most by processing method, with HTST sterilization initially most preferable. Storage at 35°F was optimum, followed by 50, 25, and 85°F, respectively.

COLOR AND FLAVOR evaluations of canned vegetables (Joffe *et al.*, 1961) and biochemical evaluations of several products (Brody *et al.*, 1960) have been reported on in this continuing study of the quality attributes of sterilized foods. This paper presents the results of color and flavor evaluation of liqueform products. Throughout this study the object has been to evaluate the effects on the quality factors of food products of high-temperature short-time (HTST), conventional, and freeze processing methods, of storage temperature, and of storage time. The information obtained has been valuable in analysis of causative factors in the deterioration of food quality.

EXPERIMENTAL PROCEDURE

The following products were evaluated: Two runs of oyster stew, evaporated milk, pea soup with ham, and tomato juice; one run of vegetable beef soup, cream of potato soup, and shrimp soup. Processing methods, storage conditions, and evaluation procedures have been described (Epstein and Ball, 1960; Joffe *et al.*, 1961). The processing times and temperatures are listed in Table 1; standard color plates used for evaluation of hue and brightness are listed in Table 2. The storage temperatures used were: frozen samples, 0°F; HTST and conventional samples, 25, 35, 50, and 85°F.

RESULTS AND DISCUSSION

Color evaluations. The effects of processing methods, storage temperature, and storage time on the brightness and hue of liqueform products were evalu-

ated. Of the three effects, storage time produced the greatest number of significant differences for both brightness and hue. This was evidenced by the fact that the greatest changes in color were experienced during the first 6 months of storage. Both hue and brightness values for all processing methods changed most rapidly during this period. Hue values continued to drop throughout the storage period, but brightness values generally leveled off during the 6-18-month period, after which there was a further decline in brightness. Of the three processing methods, conventional canning caused the greatest differences in both hue and brightness due to processing and storage. The conventionally processed samples lost their characteristic hue and brightness to a large extent because of the extensive heat treatment, but both hue and brightness deteriorated further throughout the storage period.

The HTST-processed samples exhibited the smallest changes in brightness values due to the effects of storage. Immediately after processing, brightness values were higher for HTST samples than for frozen samples except in evaporated milk. These higher brightness values for HTST samples continued

Table 1. Processing conditions for HTST-canned and conventionally canned products.

Product	Retort temperature (°F)		Heating time		Cooling time (min)	
	HTST	Conventional	HTST (sec)	Conventional (min)	HTST	Conventional
Oyster stew	300	245	85	40	2	10
Evaporated milk	300	242	75	20	2	15
Pea soup with ham	300	245	75	53	2	10
Tomato juice	300	212	60	25	2	15
Shrimp soup	300	245	130	53	2	10
Vegetable beef soup	300	245	110	53	2	10
Cream of potato soup	300	245	180	53	2	10

Table 2. Standard plates for color evaluations.

Product	NBS plate number	L	aL	bL
Oyster stew	00	85.3	-1.2	+1.3
Evaporated milk	00	85.3	-1.2	+1.3
Cream of potato soup	00	85.3	-1.2	+1.3
Tomato juice	48 ^a	26.5	+26.6	+12.7
Pea soup with ham	15	58.2	-21.0	+14.5
Shrimp soup	35	73.4	+1.0	+31.7
Vegetable beef soup	35	73.4	+1.0	+31.7

^a Gardner color plate number.

^a Presented at the Twenty-first Annual Meeting of the Institute of Food Technologists, May 9, 1961.

^b A paper of the Journal Series, N. J. Agricultural Experiment Station, Rutgers—The State University, Department of Food Science, New Brunswick, N. J.

throughout the storage period. Differences in hue values due to processing were evidenced only in one-half of the products examined. For the products where differences were significant, frozen samples maintained the characteristic hue values better than the HTST samples at the initial evaluation after processing. However, after 6–12 months of storage time, characteristic hue values deteriorated less in HTST samples than in frozen samples.

Table 3. Color of oyster stew, run No. 4.

A. Significant effects of treatments				
Treatment	Brightness signif. level (%)	Hue signif. level (%)		
Process	0.1	5.0		
Storage temperature	....	5.0		
Storage time	0.1	0.1		

B. Multiple comparison of processing method (mean values)				
Method	Brightness signif. diff.	Rank	Hue signif. diff.	Rank
HTST		1		2
Conventional		3		3
Frozen		2		1

C. Multiple comparison of storage temperature (mean values)	
Storage temperature (°F)	Hue signif. diff.
25	
35	
50	
85	

D. Multiple comparison of storage time (mean values)		
Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0		
3		
6		
12		
18		
24		

Table 4. Color of oyster stew, run No. 17.

A. Significant effects of treatments				
Treatment	Brightness signif. level (%)	Hue signif. level (%)		
Process	0.1	5.0		
Storage temperature	....	....
Storage time	0.1	0.1		
B. Multiple comparison of processing method (mean values)				
Method	Brightness signif. diff.	Rank	Hue signif. diff.	Rank
HTST		1		1
Conventional		3		3
Frozen		2		2
C. Multiple comparison of storage temperature (mean values)				
Storage time (months)	Brightness signif. diff.	Hue signif. diff.		
0				
3				
6				
12				
18				

Storage temperature was generally not a significant factor in the effects on hue, and was significant in only one-third of the products examined for brightness. When storage temperature did affect brightness values, 35°F was the optimum storage temperature and 85°F produced the most rapid deterioration of

Table 5. Color of cream of potato soup, run No. 16.

A. Significant effects of treatments		
Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	5.0	....
Storage temperature	1.0	....
Storage time	0.1	0.1

B. Multiple comparison of processing method (mean values)	
Storage temperature (°F)	Brightness signif. diff.
25	
35	
50	
85	

C. Multiple comparison of storage temperature (mean values)		
Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0		
3		
6		
12		
18		
24		

Table 6. Color of evaporated milk, run No. 7.

A. Significant effects of treatments		
Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	1.0	0.1
Storage temperature	1.0	....
Storage time	1.0	0.1

B. Multiple comparison of processing method (mean values)				
Method	Brightness signif. diff.	Rank	Hue signif. diff.	Rank
HTST		2		2
Conventional		3		3
Frozen		1		1

C. Multiple comparison of storage temperature (mean values)	
Storage temperature (°F)	Brightness signif. diff.
25	
35	
50	
85	

D. Multiple comparison of storage time (mean values)		
Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0		
3		
6		
12		
18		
24		

Tables 3-13 summarize the results of color evaluations. Joined dots indicate differences significant at the 5% level; dashes indicate no significant difference. Multiple comparisons are not presented when a particular treatment did not significantly affect both brightness and hue values.

A. Significant effects of treatments		
Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	5.0
Storage temperature
Storage time	1.0

B. Multiple comparison of processing method (mean values)		
Method	Hue signif. diff.	Rank
HTST		2
Conventional	○	3
Frozen	○	1

C. Multiple comparison of storage temperature (mean values)		
Storage time (months)	Hue signif. diff.	
0		○ ○ ○
3		○ ○
6		○
12		○ ○
18		○ ○
24		○




A. Significant effects of treatments		
Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	....	....
Storage temperature	0.1	....
Storage time	0.1	1.0









B. Multiple comparison of storage temperature (mean values)		
Storage temperature (°F)	Brightness signif. diff.	
25		
35		
50		
85		











C. Multiple comparison of storage time (mean values)		
Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0		
3		
6		
12		
18		
24		

Table 9. Color of tomato juice, run No. 1.

A. Significant effects of treatments		
Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	5.0	....
Storage temperature	0.1	....
Storage time	0.1	0.1

B. Multiple comparison of processing method (mean values)		
Method	Brightness signif. diff.	Rank
HTST		2
Conventional		2
Frozen		1

C. Multiple comparison of storage temperature (mean values)		
Storage temperature ("F)	Brightness signif. diff.	Hue signif. diff.
25		
35		
50		
85		

D. Multiple comparison of storage time (mean values)		
Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0		
3		
6		
12		
18		

A. Significant effects of treatments		
Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	....	....
Storage temperature	....	....
Storage time	0.1	0.1

B. Multiple comparison of storage time (mean values)

Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0	● ○ ○ ○	○ ○ ○
3	○ ○ ○ ○ ○	○ ○ ○ ●
6	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ●
12	○ ○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○ ○
18	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○
24	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○

Of the three factors, processing method was the most significant factor affecting both of the flavor attributes. Storage time, over the range studied, was more significant than storage temperature.

Of the three processing methods, conventional processing produced the least significant differences from the check. This was expected since the check sample was conventionally processed and stored at 35°F. The frozen samples were initially rated as being "more different" from the check than the HTST samples. However, the HTST samples generally (in 80% of the cases) received higher preference ratings than frozen samples at the initial evaluation time.

After 3 months of storage the HTST samples were rated as "poorer than" the check in all cases, and for the five products where preference of frozen samples was indicated, four of these products were rated as "poorer than" the check. This result was taken as an indication that 3 months of storage was optimum for conventionally processed samples, and not that the flavor of HTST and frozen samples underwent extensive deterioration during the 0-3-month storage period. The basis for this explanation will become evident from the results presented below.

At 6, 12, 18, and 24 months, the HTST samples continued to display significant flavor differences from the check for 80-90% of the products. The flavor preference values for HTST samples indicated that all samples were "poorer than" the check at the 3-month evaluation time; at the 6-month evaluation

time, however, the flavor preference ratings were evenly split between "poorer than" and "better than the check." After 12 months of storage the HTST samples were preferred to the check in approx 60% of the cases. Between 12 and 24 months the flavor preference for HTST samples gradually declined, by

Table 12. Color of pea soup with ham, run No. 15.

A. Significant effects of treatments				
Treatment	Brightness signif. level (%)		Hue signif. level (%)	
Process	0.1		0.1	
Storage temperature	0.1		1.0	
Storage time	0.1		0.1	

B. Multiple comparison of processing method (mean values)				
Method	Brightness signif. diff.	Rank	Hue signif. diff.	Rank
HTST		1		1
Conventional		2		3
Frozen		3		2

C. Multiple comparison of storage temperature (mean values)		
Storage temperature (°F)	Brightness signif. diff.	Hue signif. diff.
25		
50		
50		
85		

D. Multiple comparison of storage time (mean values)		
Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0		
3		
6		
12		
18		
24		

Table 11. Color of pea soup with ham, run No. 6.

A. Significant effects of treatments		
Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	....	0.1
Storage temperature	1.0	....
Storage time	0.1	0.1

B. Multiple comparison of processing method (mean values)		
Method	Hue signif. diff.	Rank
HTST		1
Conventional		3
Frozen		2

C. Multiple comparison of storage temperature (mean values)	
Storage temperature (°F)	Brightness signif. diff.
25	
35	
50	
85	

D. Multiple comparison of storage time (mean values)		
Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0		
3		
6		
12		
18		
24		

Table 13. Color of shrimp soup, run No. 18.

A. Significant effects of treatments		
Treatment	Brightness signif. level (%)	Hue signif. level (%)
Process	....	....
Storage temperature	....	5.0
Storage time	0.1	0.1

B. Multiple comparison of processing temperature (mean values)	
Storage temperature (°F)	Hue signif. diff.
25	
35	
50	
85	

C. Multiple comparison of storage time (mean values)		
Storage time (months)	Brightness signif. diff.	Hue signif. diff.
0		
3		
6		
12		
18		
24		

24 months being rated as "poorer than" the check in 80% of the cases.

The number of significant differences from the check for frozen samples was comparable to those

Table 14. Mean hedonic scale values^a for the effects of processing methods on flavor difference.

Product		Storage time (months)					
		0	3	6	12	18	24
1) Oyster stew							
Run 4	HTST	3.75	2.65	3.46	3.26	NA	4.05
	Conv.	1.44	1.74	1.44	2.32	NA	2.27
	Froz.	2.48	2.36	3.28	3.37	NA	4.12
Run 17	HTST	3.50	4.56	3.70	3.47	3.13	3.86
	Conv.	1.43	1.31	1.48	1.58	1.89	1.53
	Froz.	4.37	5.03	4.91	4.02	NA	NA
2) Pea soup with ham							
Run 6	HTST	2.46	3.84	3.71	3.94	4.24	3.71
	Conv.	1.48	1.19	2.10	1.92	2.09	2.12
	Froz.	1.89	2.41	2.84	3.34	3.54	3.01
Run 15	HTST	2.84	3.48	NA	3.57	3.99	3.27
	Conv.	1.72	2.19	NA	1.67	1.53	1.65
	Froz.	2.90	3.31	NA	2.57	3.83	NA
3) Evaporated milk							
Run 7	HTST	2.55	2.25	3.00	3.03	3.12	2.78
	Conv.	1.53	1.49	1.83	1.69	2.17	1.96
	Froz.	4.48	4.02	4.90	4.89	4.03	3.81
Run 19	HTST	3.05	2.52	2.90	2.83	3.34	3.38
	Conv.	1.45	1.59	1.56	1.77	2.05	2.30
	Froz.	3.22	5.29	3.67	2.67	NA	NA
4) Vegetable soup with beef							
Run 5	HTST	2.21	3.04	2.98	3.42	3.85	3.34
	Conv.	1.13	1.38	1.66	1.75	1.69	2.02
	Froz.	1.88	1.80	3.17	2.75	4.02	2.58
5) Potato soup							
Run 16	HTST	3.12	4.64	4.31	4.22	4.27	4.34
	Conv.	1.27	1.43	1.69	2.02	1.99	1.89
	Froz.	3.84	3.76	4.50	3.89	NA	NA
6) Shrimp soup							
Run 18	HTST	3.10	3.25	3.31	3.27	3.29	4.05
	Conv.	1.48	1.41	1.98	1.83	1.90	1.92
	Froz.	3.89	1.64	3.51	2.74	NA	NA
7) Tomato juice							
Run 11	HTST	1.87	2.94	3.00	3.14	3.68	3.14
	Conv.	1.99	2.75	2.51	2.63	2.77	2.52
	Froz.	3.55	4.59	4.86	5.45	4.10	NA

^a Numerical values represent degree of difference from the standard check. Conv. = conventionally canned. Froz. = frozen.

for HTST samples throughout the entire storage period. After 3 months, however, the flavor preference for frozen samples was generally split between "better than" and "poorer than" the check. The reason might have been the fact that evaporated milk, tomato juice, and the formulations used for the frozen soups (identical to the formulations used for the thermally processed samples) generally exhibited flavors that were "unusual" though not necessarily unpalatable to the panel.

The effects of storage temperature on the flavor attributes were similar to those reported for color attributes. Storage temperature generally did not affect the flavor of conventionally processed products except 85°F, at which flavor deterioration was extensive after 3 months of storage. The respective flavor preference values for HTST samples, from better to poorer, were 35, 50, 25, and 85°F.

ACKNOWLEDGMENTS

The authors wish to acknowledge the support of this project by the following companies and governmental agencies: United States Public Health Service; Eastern Utilization Laboratory, U.S.D.A.; Refrigeration Research Foundation; Washington Laboratory, National Canners Association; American Can Company; Continental Can Company; Campbell Soup Company; Borden Food Company; Smitherm Corporation.

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